50 RANDOM NUMBERS

If you use the RND function on its own you will get a result which falls between 0 and 1. It is, of course, real and contains a decimal point. Try PRINT RND and you will see the effect.

In order to get a range of integers you must use the INT function. For instance, you may want to find a random number in a dice throw, one to six. To do that you would use the formula:

INT(RND end-of-range) start-of-range

The dice would, therefore, be simulated using:

PRINT INT(RND*6) + 1

If, however, you wanted a range between three and seven you would type:

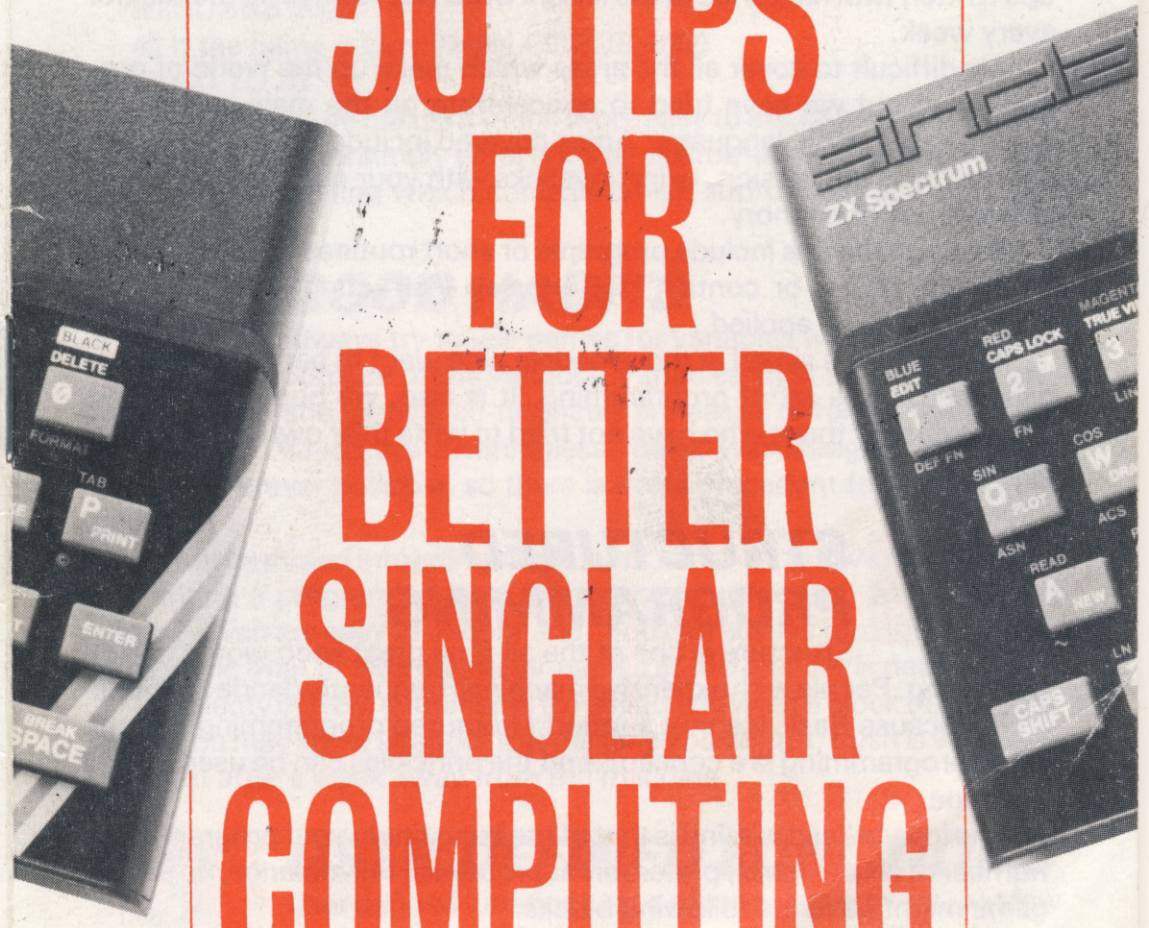
PRINT INT(RND*7) + 3

The random number generator can also be set by using RAND, followed by a number or not. Random numbers are not calculated: they are looked up in a table of figures. If you type RAND 3 the Spectrum will start by giving the third number in the table followed by the fourth and so on.

If RAND is used without a number the computer will start at a point determined by the number of separate television frames generated since the Spectrum has been switched on. That should be random enough for you.

sinclair user

50 TIPS FOR BETTER SINCLAIR COMPUTING



0 INTRODUCTION

Programming can be fun but often you will want to produce an effect on the computer though you are not able to find a routine to do it.

The *Sinclair User* team has also experienced those difficulties and we have decided to share with you a collection of 50 programming hints and tips written with reference to the letters which we receive by the sackful every week.

It is difficult to cover all the areas which make up the world of programming but we have tried to concentrate on the main aspects of writing in the Basic language. Areas covered include graphics, sound, number base conversion, using joysticks with your own programs and efficient use of memory.

Nearly all the tips include programs or short routines which illustrate the points given, or contain step by step instructions on how each technique can be applied.

The booklet is aimed at those people who want to become more experienced in the art of programming. It is also, we hope, something which will spur those who have not tried to write their own programs to do so.

1 STRUCTURED PROGRAMMING

Structure is one of the all-time great snob words of programming. People with expensive machines frequently deride the Spectrum because Basic 'cannot support structured programming'. Structured programming is a concept, and the principles can be used on any machine.

The idea to keep in mind is that of breaking down your program into a number of short blocks, preferably subroutines. For instance, an arcade game might have the following blocks:

1000 set up the screen and variables.
2000 joystick/keyboard input.
3000 result of move
4000 end of game
5000 set up user defined graphics.

The rest of the program is then a simple matter of linking the routines together:

```
10 GOSUB 5000: GOSUB 1000
20 GOSUB 2000
30 GOSUB 3000
40 If the game is over THEN GOSUB 4000
50 GO TO 20
```

Such a structure makes it much more easy to alter a program, or add extra features. You simply write another subroutine and adjust the section at the beginning which controls which subroutines are used and when.

2 GOOD HABITS

Always try to use names for variables which indicate the purpose of the variable. Variables such as 'hor' and 'ver' for horizontal and vertical co-ordinates are easier to follow than using 'x1' and 'x2' which are meaningless. Basic was designed to follow English wherever possible, so there is every precedent for keeping the tradition.

Do not be misled into using single letter variables to save space. If you are writing a program so long that space is important, you will need names which are easy to understand. You can always turn the variables into simple one- or two-character names at the end if it is necessary.

Use plenty of REM statements to remind you what a block of program does. You may know all about it at the time you write it, but it is very easy to forget after a week away from the machine.

3 USER DEFINED FUNCTIONS

User defined functions are a gift to programmers, but few use them, perhaps because they are put off by the apparent complexity of the syntax.

Think of them as miniature subroutines, which do not need to be referenced by a line number, and you will appreciate their power.

The important thing to get right is the number of variables the function will use. When you define the function you write a general instruction with variables in it. When you use it you write the precise variables or numbers you want to use in the order in which they occur in the definition.

Here is a simple example using no variables at all. It simulates throwing a six-sided die.

```
DEF FN a() = INT(RND*6 + 1)
```

Later in the program the instruction LET X = FN a() will put a number from 1 to 6 into X.

Here is an example using variables. It adds two strings together with a space between them.

```
DEF FN a$(X$,Y$) = X$ + " " + Y$
```

Later in the program, you might have the following routine:

```
100 INPUT "First name ?"; C$
110 INPUT "Second name ?"; D$
120 LET N$ = FN a$ (C$,D$)
```

You could enter "John" and then "Smith". The function would combine the two to read "John Smith".

If you are writing a program using a lot of complex manipulation of numbers or text, you may well find it saves much space and trauma to use pre-defined functions.

4 INFINITE SCROLL

It can be very frustrating, especially during a game, if the program keeps stopping and asking if you want to scroll the screen upwards.

Screen scrolling is controlled by one of the system variables, which counts the number of screen scrolls the computer will perform before it stops and asks you to press a key.

The line 10 POKE 23692, 255 will disable the feature for 254 screens. If you want to make sure that you never have to press a key to scroll, then

simply make sure that line is repeated every so often during the course of the program, by incorporating it into a loop, for instance.

5 UDG STORAGE

User defined graphics characters, or UDGs, are stored in a special part of memory which starts at address 32600. Each character is stored as eight consecutive bytes made up of eight bits each, of which each represent one pixel, or dot, on the screen.

When displayed on the screen the eight bytes form a grid. Using standard UDGs there is only enough memory for the letters A to U. Those are set up in RAM and can be changed by using instructions structured around the general formula POKE USR "graphics character" + byte number (1 to 8). For instance, the seventh byte of the letter A would be entered using the instruction:

```
POKE USR "A" + 7
```

As the UDG area of memory is protected the graphics set up within it cannot be destroyed unintentionally unless you pull the plug. Not even NEW or CLEAR will do it.

6 DEFINING UDGs

To design and set up a UDG character within a Basic program you need to plan the shape of the figure on a grid. Ink in the relevant squares to make up your character with a black or blue pen. Then take each horizontal line in turn and by it write the number sum of the line. That number is constructed by working from the left to right. For each square that is linked in write a '1' and for every empty square put a zero. For instance, in a square with line one being white, white, black, white, white, black, black, white, white.

When you have all eight numbers corresponding to the lines of the grid LOAD the binary/decimal converter which can be found elsewhere in the booklet. Type each of the binary numbers in, starting from the top of the grid and note the decimal values which the conversion program returns. At the end you should have eight decimal values. Those can be put straight into a data statement in the utility program below (line 50).

```
10 FOR K 0 TO 7
20 READ A : POKE USR "A" + K, A
30 NEXT K
40 PRINT "CHARACTER STORED"
50 DATA 0, 0, 0, 0, 0, 0, 0, 0
```

Line 10 of the program sets up a loop which will go round eight times reading the decimal values of the DATA statement into the UDG area of memory. Line 20 does the reading and POKEs, or puts, those values into the UDG area. The character between quotes in line 20 is the graphics character which you want to change to the new representation.

Line 30 completes the loop and line 40 tells the programmer that the set up procedure for that particular graphic has finished. Line 50 contains the decimal values which you obtained from the binary/decimal converter and in turn from the graphics character grid.

7 USING UDGs

Once set up, a UDG can be used in two ways within a Basic program. The first way is to enclose it within a normal PRINT statement in quotation marks. When you have typed up to the point where you want to put the graphic character into a PRINT statement go into graphics mode by holding down the CAPS SHIFT key while you press the GRAPHICS key on the top row of the keyboard. Then type the key which will print the letter of the aphabet which you are using for the UDG — 'A', for instance.

When you press the key you should get a capital 'A' because the new representation is not set up until your program is run. Once you press the RUN key and then break after setting up is complete, you should see that the graphics capitals in the listing have changed to the spaceships, rockets or aliens which you created using the character generator routine.

The other way to display UDGs is simpler but you have to use the command CHR and the code number of the graphic which you want to appear. Those codes can be found on page 183 of your Spectrum manual. For instance, the code for the graphic 'A' is 144. To display that character all you have to do is type:

```
PRINT CHR$ (144)
```

8 ANTI-PIRACY

Software piracy is a scourge which is not easily eliminated. Most professional software companies incorporate anti-piracy devices within programs so that they cannot be broken into and copied, or the code in which they are written listed.

Security has always been a problem with Basic programs as listings are easily accessible even when auto-run. There is only one simple way to combat the problem without resorting to machine code and that is to close off the avenue through which pirates can enter.

To get into a Basic program which is running, the Break key is used and an error message is printed at the bottom of the screen. The screen is made up of two parts — the lower half having access to a stream of information called #0. To stop a break-in CLOSE down the stream. If information, such as an error message, tries to access it an error occurs and the system crashes.

In order to gain benefit from that knowledge all you have to do is make line 1 of any program you wish to protect:

```
1 CLOSE # 0
```

9 SOUND EFFECTS

There is no doubt that sound is not the Spectrum's finest feature. It is very difficult to write anything remotely musical; you only have to listen to the hideous tunes produced by progressional programmers to realise that.

It is possible, however, to do rather more than a few simple BEEPs at the beginning and end of the program. Experimentation is the key, but here are a few simple ideas to try out.

If your program requires single key input — for example, in choosing items from the menu — why not alter the length of the click made by the keyboard? You can do that by the instruction POKE 23609, x where x is the length of the click. Use any number from 0 to 255 until you find one you like.

Sirens are fairly easy. The secret is to slide from one note to another with very short BEEPs and then back again. Here is a short siren routine:

```
10 FOR X=0 TO 10 STEP .5
20 BEEP .02,X
30 NEXT X
40 FOR X=10 TO 0 STEP -.5
50 BEEP .02,X
60 NEXT X
```

The smaller the value after STEP, and the smaller the duration of each note, the smoother the sound.

The really revolting sounds, however, are produced by mixing two BEEPs together. The Spectrum has no facility for doing that, but you can alternate two sounds fast enough to create a nauseating tremolo which can form the basis of a variety of noises from screeches to explosions.

Here is one such piece of aural violence.

```
10 FOR X= -10 TO 10 STEP 2
20 FOR Y=1 TO 4
30 BEEP .02,.5
40 BEEP .02,X
50 NEXT Y
60 NEXT X
```

Because the two sounds are, on their own, very short, there needs to be a loop to repeat them a sufficient number of times for the noise to register in all its glory.

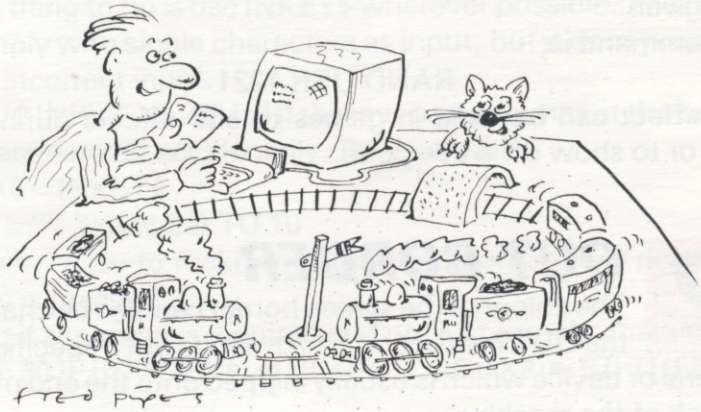
10 NOVEL CRASHES

Crashing, or bombing out, a Spectrum has become a spectators sport and many users have become fascinated, if not irritated, by the ways in which a Spectrum goes to pieces.

If you want to do it simply and deliberately one of the best ways is to type:

```
PRINT USR 1000
```

The machine should give off a buzz, the keyboard will become in-



operable and a black border will appear on the screen. If you want to show how clever you are print SINCLAIR USER IS THE GREATEST on a Spectrum at a show or in a shop and then do your PRINT USR. The rest cannot be cleared without pulling the plug.

If you want something a little more colourful, but which does not give an irretrievable crash, then type:

RAND USR 5050

A multi-coloured rectangle will appear on the screen followed by the Sinclair logo effectively resetting the machine.

Finally, if you have an EPSON FX-80 printer attached try:

RAND USR 600

11 ROM BORDER

It is possible to change the colours output to the border with a simple call to the Spectrum ROM.

The call is made to the operating system and the effect which you will get is similar to that obtained when SAVEing a computer program. First the blue and red bands, marking the header of the SAVEd program are shown and then the thinner blue and yellow bands of SAVEing. As no header information is available you will find that only one thick header signal is given.

The command is:

RAND USR 1221

and the effect can be used in games to add effects during fight sequences or to show off a title page.

12 OUT BORDER

The colour of the screen border can also be changed using the OUT instruction which sends out a specified signal to a peripheral or device which is usually clipped onto the end of the buffer at the back of the machine.

It can also affect the screen on which its signals are represented as colours. In order to make use of the border in this way it is necessary to develop a short loop routine such as the one below.

```
10 FOR K = 1 TO 100
20 PAUSE 5
30 OUT 254, K
40 NEXT K
```

Try the routine and you will find that colours flash on and off the border. If you make the PAUSE number greater the colours will run through a slower sequence. A smaller PAUSE number, except of course zero, will speed up the colour cycle.

The advantage of using the routine rather than a ROM call is that you have more control over the timing of the effect.

13 FOOLPROOF INPUTS

Writing the perfect program is not much use if imperfect human beings are capable of crashing it. When users are called upon to enter instructions it is normal to use the INPUT command, but that can cause problems. Efficient programmers ensure that even if the user makes a mistake the program will not crash.

The best thing to do is use INKEY$ wherever possible. That can only be done simply with single characters as input, but it does prevent problems with incorrect input.

The line 10 INPUT X$ will fail if the inverted commas at the bottom of the screen are deleted accidentally. Replace with:

```
10 LET X$ = INKEY$
20 IF X$ = "" THEN GO TO 10
```

Line 20 is necessary to make sure that the program will not continue unless a key is pressed.

But what if a number is required and not just any old character? Just add the line: 30 IF ((CODE X$)◄48) OR ((CODE X$)►57) THEN GO TO 10.

That will check that a number key has been pressed by examining the code of the character in question.

If you are using a menu the above method is by far the best, and as long as the relevant options are indicated by a consecutive block of letters or numbers the limits for the codes can be changed as appropriate.

If the program requires more than one character to be entered at a time, the INKEY$ routine could be made a subroutine and each individual character checked in turn to make sure it is of the right type. In that case you will have to write some lines to store all the different key presses in a single string, and then use that for text or the VAL command to turn the string into its numerical equivalent.

That will not entirely eliminate the possibility of error. It is therefore a good idea with very important data to PRINT it up to the screen to be visually checked, with an opportunity for the user to press 'y' or 'n' — again using the INKEY$ routine for safety — to confirm the accuracy of the information.

Remember, do not just be kind to the computer, be kind to the user as well — even if it is only yourself.

14 LOW PRINT

You may have noticed that the Spectrum screen display is made up of two parts. The first and main part controls the upper three-quarters of the screen and it is here that listings and program output are displayed.

The bottom quarter, usually made up of two lines, is the part of the screen upon which commands can be typed and which the Spectrum uses to ask for INPUT during a program. Information is output to this and the other part of the screen using streams. The bottom part of the screen can be controlled using the reference number # 0. Just as you could close down the bottom part of the screen using:

CLOSE # 0

so you can print on it using a print instruction suffixed with #0. For instance PRINT # 0; "USING BOTTOM SCREEN" would put the message between the quote marks at the bottom of the screen.

Other commands can also be prefixed with # 0. These include PAPER, INK and CLS.

15 EXPLOSIONS

There are several ways in which explosions can be created on the screen. The simplest is make the main part of the screen flash with colour in a loop using a routine such as that below.

```
10 FOR K = 1 TO 50
20 FOR M = 1 TO 9
30 PAPER M : CLS: PAUSE 1
40 NEXT M
50 NEXT K
```

Unfortunately you will have to redraw whatever was on the screen before the effect when it has finished as CLS has been used.

Alternatively, you could flash the border using the ROM routine or loop described in the sections on border colour change elsewhere in the booklet. There is also another ROM routine which adds an extra dimension and that is:

RAND USR 1300

It is a cross between a quick SAVE signal and a colour.

16 PUTTING IN ZERO

You may have seen some programs which start with a line numbered 0. That is a device used to protect programs against piracy. If a copyright statement is put into a line 0, it is difficult to remove unless you know something about how programs are stored in memory.

To create your own line 0, you must first write an ordinary line such as:

1 REM PIRATES WILL BE PROSECUTED

Now you must find the beginning of the program area of memory, which is given by PRINT PEEK 23635 + 256*PEEK 23636. The number printed will be the address of the start of the program.

The first two bytes of any line in a program contain the line number, so if you POKE those two bytes with 0 your line 1 will turn into a line 0 which cannot be deleted or edited in the normal way.

Thus, if the start address was 23755 you would enter: POKE 23755,0:POKE 23756,0 and the job would be done.

17 REMOVING ZERO

To remove a line 0 you must reverse the procedure outlined in hint 16. Again, find the start of the program area with PRINT PEEK 23635 + 256*PEEK 23636.

Now you must POKE the relevant line number into the two bytes at the beginning of the program.

Those bytes act as a pair, so that numbers bigger than 255, the limit for any one byte, can be held. If you are familiar with Z80 machine code at all, you might expect the two bytes to hold the number back to front, with the 'least significant byte' first, like writing 12 as 21. But that odd convention is not used for line numbers on the Spectrum.

Because you can hold up to 255 in the second byte, the first byte stands for 256es. To find out how your line number should be POKEd in, divide it by 256 and note the remainder. Then POKE the answer to the division into the first byte, and the remainder into the second byte.

For example, if the start address was 23755 and the desired line number was 1, you would enter: POKE 23755,0:POKE 23756:1. If you wanted to have a line number 4368, you would enter: POKE 23755,17:POKE 23756,16 because 256 times 17 equals 4352, plus 16 equals 4368.

Remember always to use a line number which does not exist elsewhere in the program, or you may get into trouble.

If you wish to remove a line 0 from a commercial program, in order to rewrite it or hack into it for your own purposes, that is legal. But if it is your intention to remove the line in order to copy the program in some way or pass it off as your own work, that is illegal and may even result in criminal proceedings. So be warned — you may think piracy sounds romantic but in reality it is just another name for thieving.

18 RENUMBER

A renumber routine is very useful for serious programming in Basic. Often the line numbers get so crowded there is simply no room to squeeze in any more statements. The renumber routine below asks for the new start number and the step for each new line, in other words increasing the numbers in ones, fives or 100s as desired.

It works by POKEing the two bytes which carry the line number with a new number and then searching for the next line number. It will stop at 9900 rather than change its own line numbers, which would be disastrous.

One thing it does not do is to renumber GO TO or GOSUB statements. That would require a much more complicated routine and take far longer in Basic. You will have to make a note of those yourself; REM statements are always helpful in identifying the beginning of a new program section.

```
9900 LET START = PEEK 23635 + 256*(PEEK 23636)
9905 PRINT "ENTER SIZE OF STEP": INPUT STEP
9910 PRINT "ENTER FIRST NUMBER": INPUT NUM
```

```
9915 IF ((PEEK(START + 1) + 256*(PEEK START))► = 8999 THEN
STOP
9920 POKE START,INT (NUM/256):POKE START + 1, NUM-INT
((NUM/256)*256)
9925 LET START = START + PEEK
(START + 2) + PEEK(START + 3)*256 + 4
9930 LET NUM = STEP + NUM
9935 GO TO 9915
```

19 WHICH MODEL?

Sinclair Research has so far brought out four versions of the Spectrum. You may not think that matters as all the models are bound to be the same.

Unfortunately there are some differences and it helps to know which model you have in case special instructions are given in hardware manuals and the explanations of some Basic listings provided in magazines.

To find out your model, be it 16K or 48K, type in:

```
10 PRINT IN 57342
```

There are several numeric answers to this request for information to be printed on the screen. If you own an issue one or two you should get the number 255. Issue three owners should get the number 191. That is not a hard and fast rule, however. Some users may get 161. That should not happen but if it does your machine is probably an issue three. They do say that nothing in the Sinclair world is certain.

20 48K TO 16K

If you own a 48K Spectrum there may be times when you want it to behave in a fashion similar to the 16K model.

The main reason is usually that you want to write a program for a 16K machine but cannot tell when you overstep the memory boundary on the 48K model. The other reason is that you want to see if a professional game or a program listing from a magazine will work on a 16K as your friend or relative is unlucky enough to own one.

The method of performing the change is slightly complicated to explain but the use of it simple. Just type:

```
CLEAR 32600
```

The Spectrum will then only accept 16K programs. The reason is that the CLEAR instruction moves a barrier in memory about. If you type the instruction on its own that barrier will move to a pre-defined place within the RAM giving you access to the maximum amount of memory available.

If you move the barrier down the amount of memory available shrinks as more and more RAM is left in its wake. Moving it to address 32600 gives access to approximately 16K of memory.

21 MEMORY REMAINING

To discover how much memory is left, you must find out where the free space in RAM begins, after taking account of the length of your program, and the amount of space eaten up by variables. A short program which uses an array of dimensions (20,20,10) will take up an enormous chunk of memory for the array.

The Spectrum memory is arranged so that the area for variables and calculations is after the area holding the program. That location will inevitably vary with the length of the program. It is therefore given a system variable called STKEND which contains the address of the location. Another system variable, RAMTOP, gives the address of the last byte of RAM available in Basic; there may be memory available above RAMTOP, but that will either be occupied by information about user-defined graphics or machine code which you have stored there yourself by deliberately changing RAMTOP, so you should already know how long that area is if you intend to use it.

The appropriate instructions to read those addresses and subtract one from the other are as follows:

```
10 LET STK = PEEK 23653 + 256*(PEEK 23654)
20 LET RMT = PEEK 23730 + 256*(PEEK 23731)
```

```
30 LET MEM = RMT — STK
40 PRINT "MEMORY REMAINING = "; MEM;" BYTES"
```

22 PROGRAM LENGTH

To find the length of a program written in Basic, it is necessary to discover the addresses of the beginning and end of the section in RAM which holds it.

Luckily, the computer knows those addresses or it would not be able to find the program itself. The beginning is indicated by a system variable, START. The end is indicated by another such variable, VARS, which is in fact the start of the variables area, which is space reserved for the variables set up by the program. That area is located directly after the program itself.

The following instructions will print the number of bytes occupied by the Basic program, by PEEKing the contents of both system variables and subtracting the one from the other.

```
10 LET PRG = PEEK 23635 + 256*(PEEK 23636)
20 LET VRS = PEEK 23627 + 256*(PEEK 23628)
30 LET LEN = VRS — PRG
40 PRINT "PROGRAM IS ";LEN;" BYTES LONG"
```

Remember that the length of the program is not the same thing as the space used when the program is running and all the variables have been set up.

23 MONETARY FORMAT

Many business programs require some form of monetary input showing figures in pounds and pence. Unfortunately some business users are not as adept at figures as they should be and press extra keys giving the computer ridiculous numbers. You would look silly if your balance book showed a total of £50.03233.

The program below will look at each input number and chop off any extra figures entered. It will also give the number a pound sign as a prefix.

```
10 INPUT A
20 LET A$ = STR$(A)
30 FOR K = 1 TO LEN A$
40 IF A$(K TO K) = "." THEN LET B = K
50 NEXT K
60 LET B$ = A$(B TO )
70 LET B$ = B$(1 TO 3)
80 LET A$(1 TO B — 1) + B$
90 PRINT VAL(A$)
```

Use the routine as a subroutine in one of your programs and any value input to variable 'A' will be formatted.

24 JOYSTICK COMPATIBLE

Using a joystick to control action within one of your own Basic programs may seem difficult but nothing could be easier. It is only the Kempston 'standard' with which you may have difficulty.

Most of the other interfaces use the character codes generated by the cursor keys. For instance, if you pushed the joystick to the left the Spectrum would register the code 08.

The Kempston interface is not so simple to use. To read it you can use the program routine below.

```
10 LET JOY = IN 30
20 IF JOY = 3 THEN PRINT "UP"
30 IF JOY = 4 THEN PRINT "DOWN"
40 IF JOY = 1 THEN PRINT "RIGHT"
50 IF JOY = 2 THEN PRINT "LEFT"
60 GOTO 10
```

As soon as you push the joystick in a new direction the IF...THEN statements will check the direction in which the change has been made. You can, of course, turn the program into a subroutine and put your own actions after THEN. If you want the "fire" option active within your game you will have to add an extra line to the program.

```
55 IF JOY = 16 THEN PRINT "BANG"
```

25 COLOUR CODES

There are two ways to use colour on the Spectrum. One is to write INK and PAPER statements to set the colours you want, the other is to use control codes.

The colour control codes are the easiest to use because the keys you use have the colours written over them.

To use a colour control code, go into Extended Mode — CAPS SHIFT and SYMBOL SHIFT —. Then hold down CAPS SHIFT and press the key with the appropriate colour. The cursor will change colour, and any character typed will now be in the appropriate colour.

If you delete the line, you will find the cursor deletes a hitherto unseen question-mark at the point where the colour was changed. That is the control code, invisible in the program listing but stored in the computer memory all the same.

You must remember to use another colour code at the end of the colour section to return to the original colour, usually black ink on white paper.

The colour code only affects the ink colour. If you want to change the paper colour you could either use PAPER or perhaps an additional code for Inverse Video, thus swapping the paper and ink colours around. You can write several codes in a row to get the required effect.

The Spectrum should usually handle control codes perfectly, but sometimes produces the 'dreaded buzz' at which point the computer issues a low growl and refuses to accept any input, including delete.

To deal with the buzz, just EDIT a line down from the main program to wipe out the current line and start again.

The precise causes of the buzz are beyond the scope of this booklet. Think of it as one of those idiosyncratic Clivebugs which we must all learn to love.

26 CHARACTER CODES

Character control codes can be used in place of functions such as SPACE, ENTER, CAPS LOCK and can also be used to print characters on the screen.

If you want to print a character without having all the bother of enclosing them within quotation marks you can use the principal control code instruction which is CHR$. For instance if you wanted to type the message "HELLO" on the screen you could either print: PRINT "HELLO" or you could use the command

PRINT CHR$(72) + CHR$(69) + CHR$(76) + CHR$(76) + CHR$(79)

Those codes can be found on page 183 of the Spectrum manual and each letter is put in a separate CHR$ statement. The '+' operator adds one character to another so that they appear on one line together. You could force a new line just by putting the control code in between the letters. The code for ENTER is 13 so the line

PRINT CHR$(65) + CHR$(13) + CHR$(66)

will produce 'A' followed by 'B' on the next line.

27 INVERSE VIDEO

Using inverse video is as easy as using the colour codes, but people get confused because there are several ways of doing it, notably two INVERSE keys.

The one at the bottom of the keyboard (E-mode key M) is a command just like PAPER and INK. You follow it with a 1 for Inverse and a 0 to cancel the command.

Key 4 has Inverse Video printed above it, and in conjunction with CAPS SHIFT produces the control code which will turn any further characters into inverse form.

Key 3 is the control code to reverse the operation. Remember that, unlike the colour control codes, you do not go into Extended Mode to get the codes. Just hold down CAPS SHIFT.

One set of codes Sir Clive did not print on the keyboard are those for making the characters flash. They can be found by going into Extended Mode, holding down CAPS SHIFT, and pressing keys 8 and 9. Key 9 turns the flash on and key 8 turns it off.

To make matters even more complicated, a completely different

method is used to obtain the inverse of the block graphics on keys 1 to 8. To get those, all you need to do is hold down CAPS SHIFT while in graphics mode.

When the ZX-81 was produced it had all the block graphics possible each on its own key. But there were so many extra functions to include on the Spectrum that the set got chopped in half, with one half the inverse of the other half.

The change is an excellent example of what computer manufacturers call 'enhancement', usually a new way of doing things which makes life twice as difficult for the user.

28 SOFT-RESET

When programming in Basic it is annoying to have to pull the plug every time you want to remove some user defined graphics quickly from the graphics area of memory or nullify the effects of a program so that the system is reset.

It is possible, however, to reset the system:

RAND USR 0

When you type the command in and execute it by pressing ENTER the screen should display a large black rectangle which, after a few seconds will disappear to be replaced by the Sinclair logo.

The explanation is simple. Typing RAND USR will invoke machine code at a specified address. The number, zero, after the command sets the Spectrum running at address 0000 which is the start of the Basic interpreter and operating system.

29 SHORTHAND LOGIC

Although Basic was designed to be as like English as possible, the logic operations : AND, OR, =, ◄ and so on are often confusing unless used in very simple forms. In fact, used properly, they can increase the speed of a program.

In Sinclair Basic, the expression IF A = B THEN GO TO 100 has an obvious meaning. However, the computer works the meaning out in a rather odd way. The expression A = B is treated as a number, just like SIN X has a numerical value. The value of A = B will be 1 if true and 0 if false. The same applies to other operations.

That allows you to rewrite complicated IF statements in a shorthand logic which relies on the numerical values.

Take the line: 10 IF A = B THEN LET X = X – 1. That could also be written as follows: 10 LET X = X – (A = B). If A does not equal B then X does not change. If it does then 1, the value of A = B, is subtracted from X.

There will be already a small saving in speed but because IF is no longer used a number of similar conditions can be added together.

10 IF A = B THEN LET X = X + 1
20 IF A►B THEN LET X = X – 1
30 IF A◄B THEN LET X = X + 7

can be written:

10 LET X = X + (A = B) – (A►B) + (A◄B)*7

Good programmers may use a dozen or more such conditions in a single line to save both time and space.

The concept can be expanded using the following further facts: (A OR B) is 1 if either A or B is not equal to zero. IF A THEN LET X = X + 1 means exactly the same as IF A◄►0 THEN LET X = X + 1. (A AND B) has the value of A if B is not equal to zero. (NOT A) is 0 if A is not zero. The full list can be found on page 64 of the original Spectrum manual.

Logic operations are not easy to follow without practice, but when mastered you will find your programs are far more efficient and less likely to carry mistakes than if you use dozens of IF statements.

30 BETTER DRAW

Drawing line figures on the screen is irritating because it usually means that you have to write lines containing long lists of co-ordinates mixed up with DRAW and POINT commands.

A simple way around that is to write a subroutine consisting of one DRAW command. Then set up your co-ordinates in an array and feed them through two simple variables called x and y. In that way you will be better able to keep track of what you draw on the screen. The routine will look something like the program outlined below.

```
10 DIM A(6): REM EVEN NUMBERED ARRAY FOR CO-ORDINATES
20 SET UP...
30 AS MANY...
40 VARIABLES...
50 AS YOU NEED...
60 LET X = NEW X CO-ORD
70 LET Y = NEW Y CO-ORD
80 GOSUB DRAW
90 REM SUBROUTINE DRAW
100 DRAW x,y
110 RETURN
```

Take the above outline as your guide and you will find writing graphics routines easier.

31 NUMERIC SORT

Sorting information into ascending numeric order is something with which business people are familiar. The program below is a simple sort routine. It takes numbers from one array and transfers them in order of ascendancy into another.

```
10 LET N = 0
20 DIM A(5)
30 FOR K = 1 TO 5
40 INPUT A(K)
50 NEXT K
60 LET B = A(1)
70 DIM C(5)
80 FOR M = 1 TO 5
90 FOR K = 1 TO 5
100 IF A(K) B THEN LET B = K: LET D = K
110 NEXT K
120 LET C(N) = A(D)
130 LET N = N + 1
140 LET AD = 9999
150 FOR K = 1 TO 5
160 PRINT C(K)
170 NEXT K
```

32 SORTING CHARACTERS

Sorting characters into alphabetic order is no more difficult than sorting numbers. The only problem is that you have to find the numeric value of each character using the CODE instruction.

In the alphabet the letter A comes before the letter B. Unfortunately the computer has no such knowledge but as each character has a number representation you can compare the values of characters using the IF...THEN statement.

The simplest way to sort a string of characters, making sure that they are all capital letters, is to dimension three variables. The first is empty but will hold the result, the second holds the string to be sorted and the third is the letter under consideration or the last lowest value character.

Look at the first character in the string and store its value. Then look at the second character. If the value of the second character is lower than that of the first then put that value into the variable, replacing the first one. Then go to the next character on the string and compare it with the last value.

When you get to the end of the string the first time around put the character whose value is in the variable into the empty string. Then check to see if the two strings are of the same length. If they are not then the sort has not been finished and a further round of comparisons must take place.

After the first round of comparisons has been made, however, a new variable must be defined. That contains the value of the last letter put into the string which you are building out of nothing. Then every comparison must satisfy two conditions. Is the value lower than the preceeding one and is it higher than the last letter entered into the string which is being built? If the answer is yes to both conditions then the value replaces the old lowest value and the comparison continues. Comparisons will continue to be made until the two strings are equal, that is, they have the same number of characters in each, the latter being sorted into alphabetic order.

33 AUTO CAPS LOCK

When you are writing a program which needs to recognise pieces of text entered via the keyboard by the user, the last thing you want to do is check every input to see if the CAPS LOCK is on or lower case letters are being used.

The best way to avoid that is to put the CAPS LOCK on automatically within the program before asking for information.

POKE 23617, 8

The address used, 23617, tells the computer which cursor mode it is in. K means command, L means line and C means Capital letters. The above command will give you a 'C' cursor and typing INPUT will provide you with capitals. Type in the program below and you will see for yourself.

```
10 POKE 23617, 8
20 INPUT A$
30 PRINT A$
40 GOTO 10
```

34 BINARY/DECIMAL

The following program converts Binary numbers into decimal. You may find it useful for working out the correct decimal numbers for UDGs — see tip 6 — as well as other uses.

```
10 REM BINARY TO DECIMAL
15 LET DEC = 0
20 PRINT "ENTER BINARY NUMBER"
30 INPUT A$
40 LET X = LEN A$
50 FOR N = X TO 1 STEP -1
60 LET DEC = DEC + VAL(A$(N))*2I(X - N)
70 NEXT N
80 PRINT "DECIMAL VALUE OF";A$;":" ' ' ;DEC
90 STOP
```

35 DECIMAL/BINARY

The following program will convert decimal numbers into binary.

```
10 REM DECIMAL TO BINARY
20 PRINT "ENTER DECIMAL NUMBER"
30 INPUT X : LET DEC = X
40 LET A$ = ""
50 IF INT(DEC/2) = (DEC/2) THEN GO TO 100
60 LET A$ = "1" + A$
70 LET DEC = DEC - 1
80 IF DEC = 0 THEN GO TO 150
90 GO TO 110
100 LET A$ = "0" + A$
110 LET DEC = DEC/2
120 GO TO 50
150 PRINT "BINARY FOR ";X;" IS:" ' ' ;A$
160 STOP
```

36 HEX TO DECIMAL

It is often necessary to convert a hexadecimal value into denary, or base 10, in order to poke those values straight into memory. As you may realise most magazines list machine code pro-

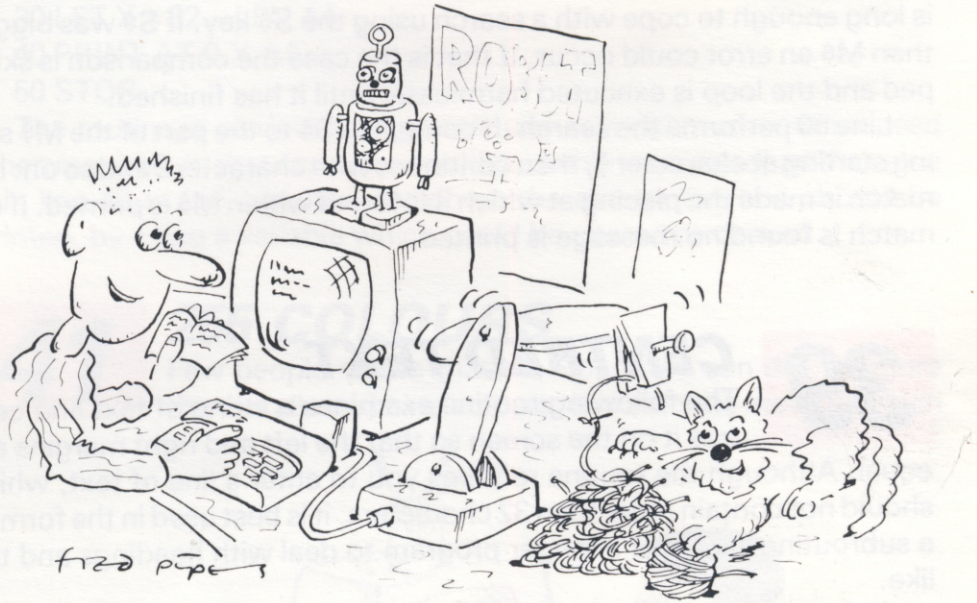
grams in hexadecimal code. The program below will convert hex to denary.

```
10 LET SUB = 1: LET DEC = 0
20 INPUT"HEX"; HEX$
30 LET N$ = HEX$ (LENS HEX$)
40 LETHEX$ = HEX$ (1 TO (LENS HEX$ – 1)
50 GOTO 120:
60 IF LEN HEX$►0 THEN GOTO 30
70 PRINT"DENARY";DEC
110 STOP
120 LET F = CODE N$
130 IF F ◄ 57 THEN LET L = F – 48
140 IF F ◄ 65 THEN LET L = F – 55
150 IFXF ◄ 97 THEN LET L = F – 87
160 LET DEC = DEC + L*SUB
170 GOTO 60
```

37 DECIMAL TO HEX

As many monitor programs display machine code in the hexadecimal number notation, where one to nine is followed by A to F, representing the numbers 10 to 15, a conversion program for decimal to hexadecimal is required. In the program below all you have to do is type in the denary, base 10 number, and it is automatically converted to hexidecimal, base 16.

```
10 INPUT "DENARY:"; DEN
20 LET BAS = 4096
30 LET HEX$ = ""
40 LET SUB = INT(DEN/BASE)
50 GOTO 130
60 LET DEN = DEN – SUB* BASE
70 LET BASE = INT(BASE/16)
80 IF BASE◄1 THEN GOTO
90 GOTO 70
100 FOR K = 1 TO 3: IF HEX$ (1) = "0" THEN LET HEX$ = HEX$(2
TO): NEXT K
110 PRINT "HEXADECIMAL:"; HEX$
120 STOP
130 IF SUB◄ = 9 THEN LET HEX$ = HEX$ + CHR$ (SUB + 48)
140 IF SUB►9 THEN LET HEX$ = HEX$ + CHR$ (SUB + 55)
150 GOTO 50
```



38 STRING SEARCHING

To search for a string within another string you will need two string variables. The first contains the string upon which the search is to take place and the second contains the string for which we are searching. The program below demonstrates the procedure.

```
10 INPUT "MAIN STRING"; M$
```

```
20 INPUT "SEARCH KEY"; S$
30 FOR K 1 TO LEN(M$)
40 IF K LEN(S$)► LEN(M$) THEN GOTO
50 IF S$ = M$(K TO (LENS(S$)) THEN PRINT"MATCH AT";K
60 NEXT K
```

Line 10 asks for the main string to be entered and line 20 accepts the string for which you are searching within M$. Line 30 sets up a string which will loop until all of M$ has been searched. Line 40 will make sure that M$ is long enough to cope with a search using the S$ key. If S$ was bigger than M$ an error could occur. If that is the case the comparison is skipped and the loop is executed harmlessly until it has finished.

Line 50 performs the search. It compares S$ to the part of the M$ string starting at character 1, then continues with character 2 and so on. If a match is made the placing at which it is found within M$ is printed. If no match is found no message is printed.

39 CENTRED TEXT

The following routine examines a string of text and centres it on the screen so that the left and right margins are equal. Although the routine requires you to enter a line of text, which should not contain more than 32 characters, it is best used in the form of a subroutine in part of a longer program to deal with headings and the like.

```
10 PRINT "ENTER YOUR LINE OF TEXT"
20 INPUT A$:CLS
30 LET X = LEN A$
40 LET X = INT (32 – X)/2
50 PRINT AT 0,X;A$
60 STOP
```

If you want to centre more than one line of text, change the 0 in line fifty to a variable such as Y. Then arrange to have Y increased by one each time the routine is used, so that the lines will be printed one under the other.

40 RANGING RIGHT

Sometimes, when printing text on the screen, it is desirable to have the right hand margin straight and the left hand margin ragged, the reverse of normal procedure.

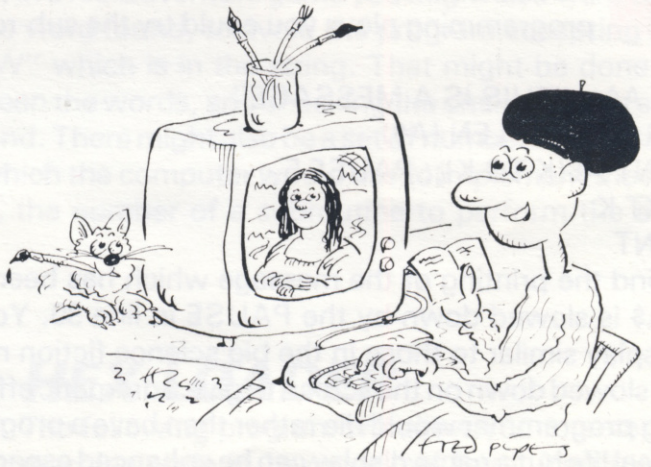
The following routine takes a line of text, which must be no more than 32 characters long, and prints it to the right hand margin.

```
10 PRINT "ENTER LINE OF TEXT"
20 INPUT A$:CLS
30 LET X = 32 – LEN A$
40 PRINT AT 0,X;A$
50 STOP
```

The routine is obviously of greater use as a subroutine to be used when required. In that case you would probably want to adjust the value 0 in line 40 to indicate how far down the screen the text should be printed, by using a variable which could be altered as desired.

41 255 COLOURS

Few people realise that the Spectrum can display more than its allotted nine colours. It is a simple method which



combines UDGs and the little-used OVER instruction.

First construct two UDGs in the chessboard fashion shown in the two diagrams above. Then you are ready to print new colours. The program below will demonstrate the technique and uses the UDGs "A" and "B" which have already been set up.

```
30 PRINT AT 10,10; INK ;"A"
40 OVER 1
50 PRINT AT 10, 10; INK ;"B"
60 OVER 0
```

What you should have on the screen after running the routine is a character square containing a new colour. Experiment. By controlling the INK colour with a simple FOR...NEXT counting loop you can cycle through all the 255 colours available.

42 SLOW PRINT

To add a science fiction effect to your armoury of game programming ploys you could try the sub-routine shown below.

```
10 LET A$ = "THIS IS A MESSAGE"
20 FOR K = 1 TO LEN (A$)
30 PRINT A$(K TO K);: PAUSE 5
40 NEXT K
50 PRINT
```

You will find the printing of the message which has been put into the variable A$ is slowed down by the PAUSE in line 30. Your computer gives a display similar to those in the big science fiction movies where printing is slowed down on the screen to give a dramatic effect. Any self-respecting programmer would die rather than have a program acting as slowly in real life but a game display can be enhanced especially if you re-define the character set to produce square, futuristic, lettering.

43 TEXT SEARCH

When writing programs such as adventure games it is often convenient to have a string which contains a whole series of words end-to-end, in order to save space instead of using huge arrays. The problem is to search for a particular word in the string.

The following program does just that, using as an example a list of directions which, in the context of an adventure game, might refer to the various movement commands.

```
10 LET B$ = "NORTHSOUTHEASTWESTUPDOWN"
20 INPUT"ENTER YOUR WORD";A$:IF A$ = "" THEN GO TO 20
30 LET X + LEN B$ – LEN A$ + 1
40 LET N = 1
50 IF B$(N TO (N + LEN A$ – 1)) = A$ THEN GO TO 100
60 IF N = X THEN GO TO 200
70 LET N = N + 1:GO TO 50
100 PRINT "YOUR WORD IS IN THE LIST"
110 STOP
200 PRINT "YOUR WORD IS NOT IN THE LIST"
210 STOP
```

Of course, in a real adventure game you might also want to check the validity of the word found, to avoid the program accepting something like "UPDOW" which is in the string. That might be done by having spaces between the words, and checking the characters on each side of the word found. There might also be a set of numbers or characters after each word which the computer would use to implement the instructon: for instance, the number of a subroutine to perform the action "GO NORTH".

44 HEX LOADER

The following program will allow you to enter a block of machine code in hexadecimal form. You may input as many pairs of hexcode characters as you wish, and the letter S will stop

the program when you have finished.

The program first asks for the starting address to which the code is to be sent.

```
10 INPUT "STARTING ADDRESS";ST
20 INPUT "ENTER STRING OF HEX";A$
30 IF A$ = "" THEN GO TO 20
40 IF A$(1) = "$" THEN GO TO 130
50 LET A = CODE A$(1):LET B = CODE A$(2)
60 LET A = A - (A►64)*55 - (A◄58)*48
70 LET B = B - (B►64)*55 - (A◄58)*48
80 LET C = 16*A + B
90 POKE ST,C:LET ST = ST + 1
100 IF LEN A$ = 2 THEN GO TO 20
110 LET A$ = A$(3 To)
120 GO TO 40
130 STOP
```

Do remember to enter all the letters in the hexcode as capital letters.

45 FILL

You can draw lines and circles on the Spectrum, and it is easy to link them to form all sorts of shapes. But unfortunately there is no command you can use to colour them in.

There are several ways of filling in shapes. One is to draw a series of lines one on top of the other, instead of the outline, but that requires a formula for the shape. It is easy with rectangles or squares but more complex with curves or irregular shapes.

The following program is one solution to the problem. It examines each pixel in turn, scanning from left to right across the screen. When it finds a dot, it starts drawing a row of dots until it comes across another one. The program is slow, but it does the job; a really good fill routine would require machine-code, which is beyond the scope of this booklet.

As an example, the program starts by drawing a square

```
10 CLS
20 PLOT 165,120: DRAW 0,-81: DRAW -81,0: DRAW 0,81:
DRAW 81,0
30 LET KON = 1
40 FOR Y = 175 TO 0 STEP -1
50 FOR X = 0 TO 255
60 IF POINT(X,Y) = 1 THEN LET KON = 1 - KON
70 IF KON◄1 THEN PLOT X,Y
80 NEXT X
90 NEXT Y
```

The program is very slow. It can be improved by altering the limits of the variables x and y in lines 40 and 50. At present they cover the whole screen, but if you know the area in which the shape to be filled is located, then you could have the program scan only that narrow range.

46 CHARACTER CHANGE

User defined graphics are all very well, but there are only 21 of them. If you want more you can completely rewrite the character set. To do that you must construct your own characters, store them in memory, and then convince the Spectrum to use yours instead of those in ROM.

It is not as difficult as it sounds. Let us assume you want to alter the alphabet and numbers only, which will leave keywords and the like unchanged thus avoiding too many problems reading your program listing. It will nevertheless give you 82 possible UDGs, which should be more than enough.

The following program will do the job. Numbers underlined and in brackets are equivalents for the 16K Spectrum.

```
10 CLEAR 63999(30999)
20 FOR X = 0 TO 767
30 LET Y = PEEK(15616 + X)
40 POKE 64000(31000) + X,Y
50 NEXT X
```

The program simply transfers the existing character set to an area above RAMTOP. You are now set to alter those characters you wish to change.

Prepare your character set as if you were using user define graphics. To load them in, use the following routines:

For the numbers 0-9

```
60 FOR X=64128(31128) TO 64207(31207)
70 READ NUM
80 POKE X,NUM
90 NEXT X
100 DATA.....
```

The DATA statements contain the new design for the character as in creating UDGs, i.e. a series of eight numbers for each character, either as decimal numbers or binary numbers using BIN. For capital letters change line 60 to

For X=64264(31264) TO 64471(31471).

For lower case letters change line 60 to

FOR X=64520(31520) TO 64727(31727)

If you want to change the entire set, use the values for X given in the first program in line 60 of the second.

Having completed the hard work, you are now set to fool the computer into preferring your set over its own. When the computer wants to print a character, it looks at a system variable called CHARS, which contains the address in ROM of the character set. You can change that address to make it refer to your own set.

The following instructions make the appropriate change:

```
10 POKE 23606,0(24)
20 POKE 23607,249(12)
```

You will of course want to save the new character set and load it in to one of your programs later. Save it using SAVE "name" CODE 64000(31000),768 and LOAD it in using something like 10 CLEAR 63999(30999):LOAD ""CODE at the beginning of the program.

47 LIST FILES

The following program lists the names of programs on a tape and loads the one selected. It stores the names of up to ten programs, and each name can be up to ten letters long. Machine-code programs should be given a name starting with the letter "X".

```
10 REM LISTING PROGRAMS
20 DIM A$(10,10)
30 PRINT "PRESS 'L' FOR A LIST OF PROGRAMMS" ' "PRESS 'N'
TO NAME PROGRAMS"
40 GOTO 50+(INKEY$="L")*50+(INKEY$="N") *100
50 GO TO 40
100 CLS
110 PRINT # 0; "SELECT A TO J TO LOAD PROGRAM"
120 FOR X=0 TO 9
130 PRINT AT X,0;CHR$(X+65),A$(X,1 TO)
140 LET B$=INKEY$
150 IF B$="" THEN GO TO 140
160 GOTO 170-(((CODE B$)◄65)OR ((CODE B$►74)))*30
170 LET NUM=(CODE B$)-64
180 CLS:PRINT "START TAPE AND PRESS ANY KEY": PAUSE 0
190 IF A$(NUM,1)="X" THEN GOTO 300
195 LOAD A$(NUM,1 TO):STOP
200 CLS
210 FOR X=0 TO 9
220 PRINT AT X,0;CHR$(X+65),A$(1 TO)
230 NEXT X
240 PRINT " " "TO CHANGE OR ADD NAME," ' "PRESS LETTER
AND ENTER NAME"
245 PRINT "PRESS $ TO STOP"
250 PRINT "START M/C NAMES WITH THE LETTER X"
260 LET B$=INKEY$: IF B$="" THEN GO TO 260
265 IF B$="$" THEN GO TO 30
270 IF (((CODE B$◄65) OR (CODE B$►75) THEN GO TO 260
280 INPUT "ENTER NAME"; C$:IF LEN C$►10 THEN GO TO 280
290 LET A$(76-CODE B$)=C$:GO TO 200
300 LOAD A$(NUM,1 TO) CODE:STOP
400 SAVE "FILE" LINE 30
```

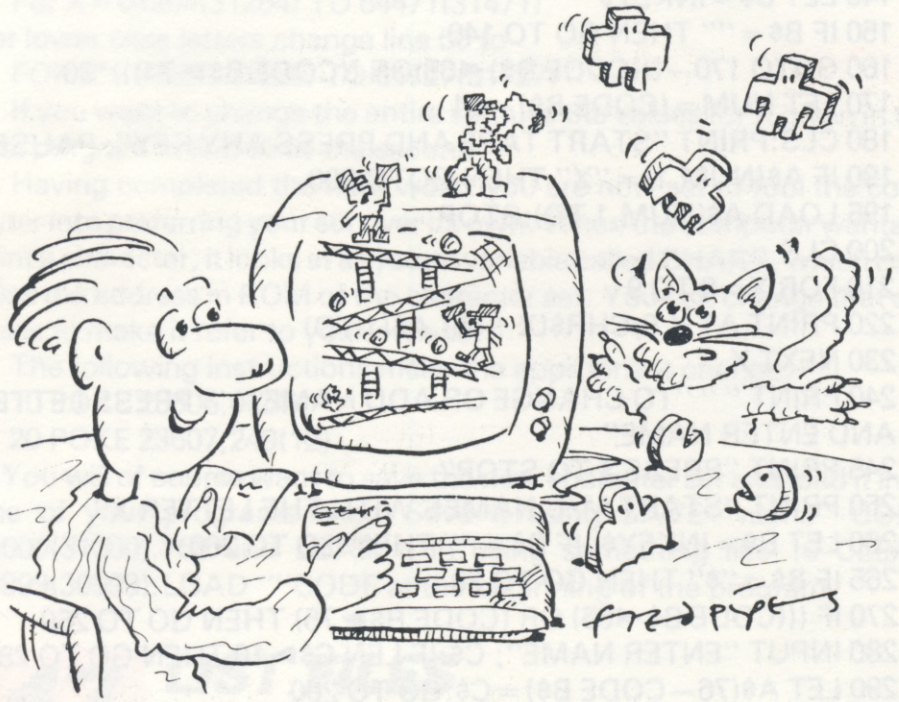
Two notes: Always write your program names in capital letters, and always save the program by typing GO TO 400..

48 ANIMATION

Animation of a character could not be simpler but it is the most effective technique which can be used on the screen.

Firstly you must design the character which you want to animate and put it in a character square. Then make it into a UDG using the techniques outlined elsewhere in this booklet.

Then, using character squares again, show the positions into which your characters can get. For instance a stick man or woman might move



arms and legs up and down. Design UDGs which illustrate the final positions into which the limbs will move.

Now to the animation. Print the first character which you designed onto a position on the screen. From here you will have to make a choice. If your character is to stand still, use the sequence of movement which you have created with UDGs in the same position. As you print one, then the next and then the next, so the impression of movement will be achieved. The effect is rather like sketching many pictures of a pin man hundreds of times on different pages in an exercise book but in different poses. As the pages are flicked so the pin man appears to move.

If you want the man to move about the screen you can use the PRINT AT instruction to move him up, down or across the screen. The movement effect will be the same and the eyes will be deceived.

49 CONTROL KEYPAD

A control keypad is simply a set of keys to manipulate what is displayed on the screen, usually to move an object around such as the hero of an arcade game.

The following routine uses keys Q,A,O and P for Up, Down, Left and Right to move a character one space at a time. It also checks to ensure the character does not move off the edge of the screen. The character used is "?", and starts at co-ordinates 10,15.

```
10 REM CONTROL KEYPAD
20 LET X=10:LET Y=15
30 LET X=X+(INKEY$="P")-(INKEY$="O")
40 LET Y=Y-(INKEY$="Q")+(INKEY$="A")
45 GOTO 50+(INKEY$="S")*50
50 LET X=X-(X►31)+(X◄0): LET Y=Y-(Y►21)+(Y◄0)
70 PRINT AT Y,X;"?"
80 GO TO 30
100 STOP
```

Lines 30 to 50 use logic operations instead of IF statements. A full explanation is given in tip 29. Line 45 makes the program stop if "S" is pressed, and go to line 50 if not.